

one of the most basic and important functions of the eye is to receive light. The eye is also a receptor of other sensory stimuli such as sound, touch, taste, and smell. The eye is a complex organ composed of many different tissues and structures that work together to form a functional unit. The eye is a remarkable organ that is able to detect and respond to light, and it is also able to detect and respond to other sensory stimuli.

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THE BIOCHEMISTRY OF LIGHT

CHLOROPHYLL AND THE BIOCHEMISTRY OF LIGHT

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By Kiester, Edwin

ute of the scant light, and during the "blue hour," when the light is fading fast, she and the children hug the windows, painting, drawing or studying. Dinner comes at four P.M., but the children seldom venture outdoors afterward—for fear of the trolls, those evil dwarfs who live in the darkest part of the forest because sunlight turns them to stone. Mørketiden liberates them to perform their foul deeds anywhere, especially in a child's imagination.

The other end of the age spectrum also has its problems with mørketiden, as I learned at the Heracleum Eldre-

senter, a facility operated by the local pensioners' union. As most people know, sunshine is central to building strong bones. Rays falling on the skin convert a hormone into the substance we know as vitamin D, a necessity in calcium metabolism. Children who lack vitamin D develop a bone deformity called rickets. Less well known is the fact that vitamin D deficiency appears to accelerate osteomalacia, a shrinkage and softening of bone in older people that often leads to fractures. To combat both osteomalacia and arthritis, the center offers a program of

exercise, physical therapy, nutritious cafeteria meals and diet instruction. On the day of my visit, the menu featured fresh cod with liver and roe—the customary Norwegian supplementary source of vitamin D.

Tromsø has a tradition of keeping active during mørketiden. Mere darkness, for instance, is not allowed to interfere with love of the outdoors. Late one afternoon as I strolled through a suburban area of the city, I heard a

GEO DATA/ THE BIOCHEMISTRY OF LIGHT

The biochemistry of light and the human body is not yet completely understood. Most of us have observed that we have a built-in "clock" that tells us when to sleep, eat and perform other bodily functions. The science of chronobiology has grown up to chart these daily cycles, called circadian rhythms (from the Latin for "about a day"), and to investigate which are innate, which are learned and which are responses to light and darkness. Among the phenomena observed are daily rhythms in sleeping and waking, body temperature, excretion of certain chemicals in the urine and secretion of adrenal hormones.

Repeated studies have shown that humans deprived of light cues (in caves or in sleep laboratories) establish their own internal clock, which runs in a cycle of about 25 hours and 15 minutes. Sleeping and waking and other cyclical functions adjust to the new routine. When the subjects are returned to a normal environment, they revert to 24-hour days, although some experience temporary problems of readjustment.

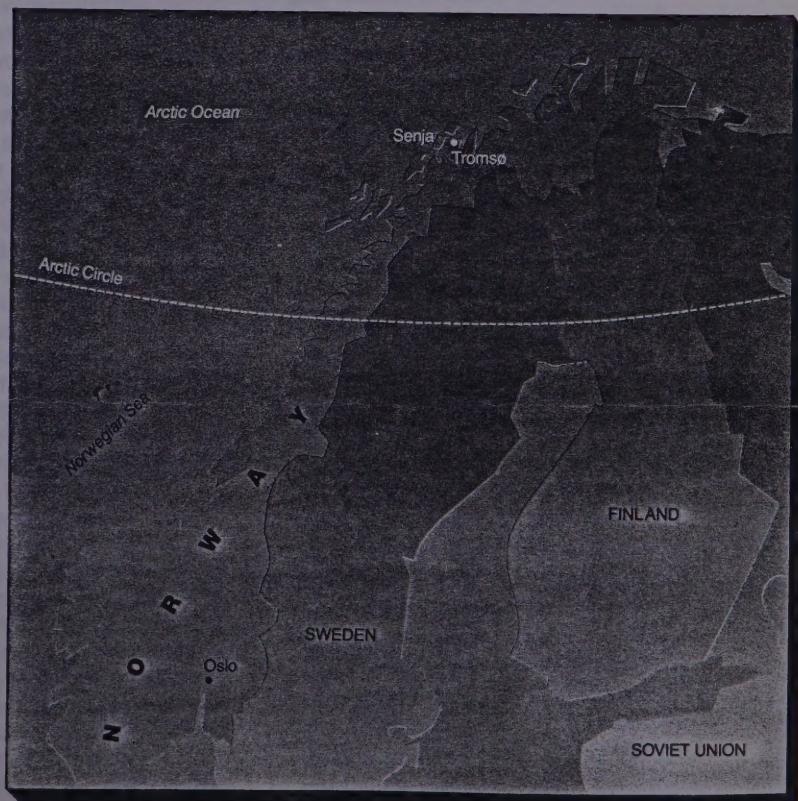
The seasons affect our behavior, too, possibly because of changes in the length of the days. Psychiatric disorders and certain physical illnesses, such as ulcers, increase in autumn. There is also evidence that humans are more fertile in summer.

The intriguing question is, How does the body regulate these events? Bio-

chemically, a full explanation is lacking. The most popular hypothesis is that light entering the body through the eyes and falling on the retina stimulates certain unidentified chemical receptors on the retina's surface. The stimulus then moves along a portion of the optic nerve through the hypothala-

mus (the brain center that governs a large portion of the endocrine system and such bodily functions as temperature, blood pressure, pulse rate and perspiration) to the pineal gland.

The role of the pineal gland in light-mediated events is now being investigated intensively. The pineal is a small



ge swishing sound and noticed a line of overhead lights strung at intervals across the hillside. Rounding a corner of firs, I found a line of cross-country skiers huffing their way along a well-traveled trail.

There is also a flurry of indoor activities. The university calendar is crowded with lectures, concerts, meetings, etc. "Mørketiden is a time of intense work," said Åre Johnsen, the university's director of public affairs. "The best-attended lectures are in December and January." Lingjaerde elaborated: "The dark time is a stimulus

for social life. People have parties or dinners and family gatherings. They can't go into the mountains and do many of the things they do in summer, so they seek some sort of compensation for living this unusual sort of life."

People seem almost to fear being alone. According to one study, Tromsø, with 45,850 people, has more than 4,000 restaurant seats, the largest per capita in Norway. The townspeople also spend more money on restaurant meals than do residents of any other Norwegian city. Restaurants close early in Norway (Tromsø's most popu-

lar eating place, the Fiskekrogen, stops serving at six-thirty P.M.), but every chair seems to be occupied every night.

Fortunately for the beleaguered city, Christmas comes along to brighten the darkest days of mørketiden. "It is a very long Christmas," Åre Johnsen said. The festivities begin around December 10 and don't wind down until mid-January.

Santa Claus and commercialism have come to Tromsø, but many age-old traditions linking the birth of Christ and the December 21 winter solstice survive. For example, the city festoons the entire main street in an arch of lights to remind people of the absent sun. Tromsø also carries out the tradition of the Christmas feast. "It is two solid weeks of eating and drinking," one woman said, and then proceeded to enumerate the foods without which her Christmas table would be incomplete. These included a cold table groaning with ham, beef and Norwegian cheese; at least four kinds of herring; the local shrimp in various salads and pâtés; Norwegian caviar; the marinated salmon *gravlaks*, for which each Norwegian appears to have his personal and secret recipe; smoked salmon and fermented trout.

light, the researchers were able to lift his depression.

As for the physical changes brought about by the sun, they fall into two categories: good and bad. Sunshine has been called "the greatest carcinogen of them all," because prolonged exposure to the sun's rays can cause skin cancer. The incidence of this form of the disease, while one of the least virulent, is decidedly on the rise, especially among fair-skinned people who insist on sunbathing. Sunshine, which promotes the synthesis of vitamin D, is also critical to calcium metabolism, and the lack of it can cause rickets in children during the bone-forming years and osteomalacia, or weakening of the bones, in the elderly, especially those confined indoors.

Through separating beneficial waves from damaging ones, scientists are learning that different types of light waves have different uses in the field of medicine. For instance, short-wave ultraviolet light (UV-C), which kills bacteria, is used for sterilization in hospitals; middle-wave ultraviolet light (UV-B) is used as treatment for some skin diseases, primarily skin cancer, acne and eczema; long-wave ultraviolet light (UV-A), if used with the appropriate drug, is an important ingredient in combating psoriasis; and blue light is now the standard treatment for neonatal jaundice, a once fatal liver malfunction common in newborns, particularly those born prematurely.

Christmas itself lasts for three days. The family gathers on December 24, the excitement of the children building throughout the day. In midafternoon, they are served a special Christmas porridge containing a single lucky almond. The child who discovers it will have good fortune throughout the year. At five P.M. the church bells ring in Christmas, and the tree is lighted, often with candles. The family joins hands and dances around the tree, after which gifts are distributed. Christmas Day is set aside for church and family, the next day for visits to friends and neighbors. The season continues with an elaborate New

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